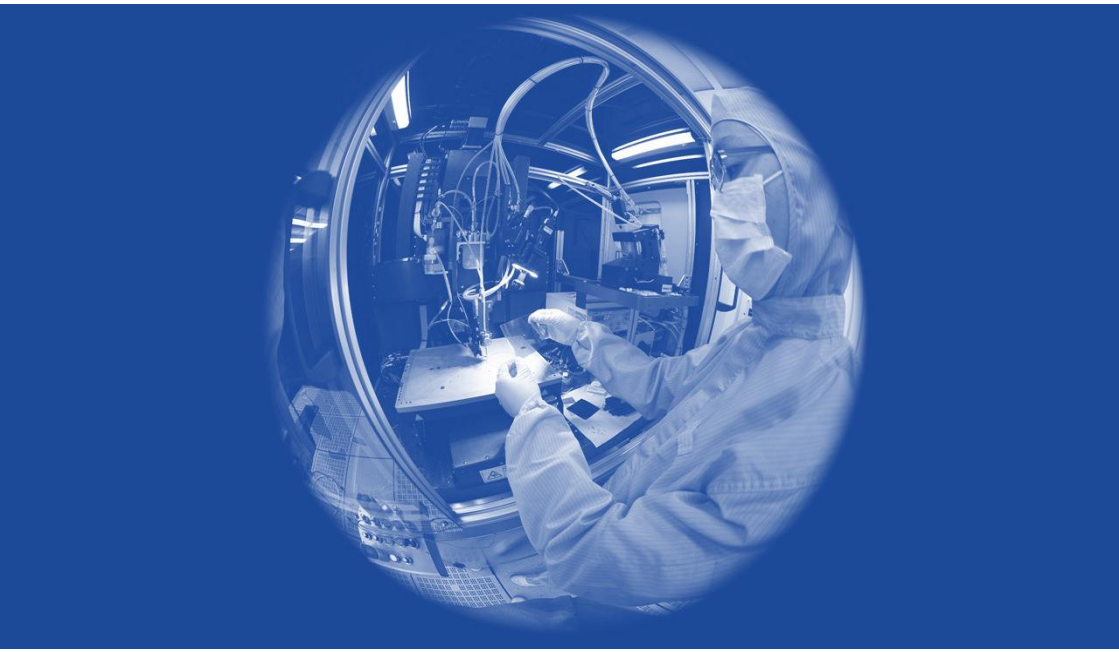
# E6NanoFab

## Enabling Cutting-edge Research



NUS National University of Singapore | College of Design and Engineering


## About Us

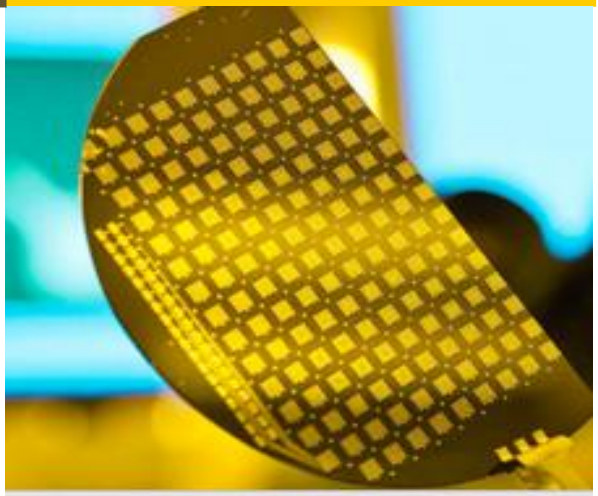
E6NanoFab is a micro-nanofabrication research center that streamlines and facilitates multi-disciplinary academic and industrial research activities in nanotechnology and microelectronics.

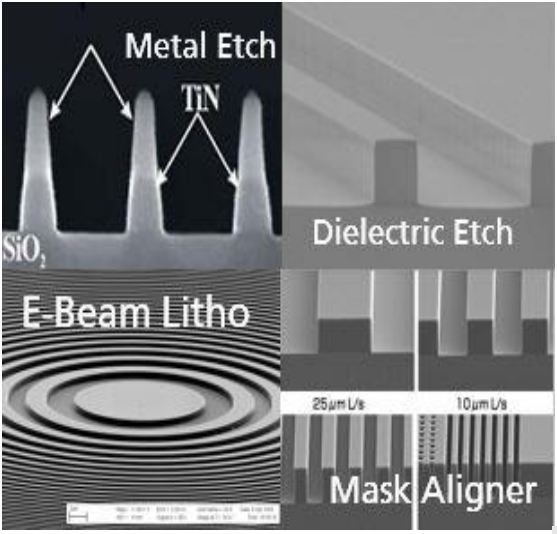
- Class 10, 100, 1000 and 10000 cleanroom.
- Over 100 characterization and process tools across the 2746 sqm laboratories floor space.

## Capability

We support full fabrication process flow including frontend and backend processing, and packaging.

- Full 8“ (200mm) wafer processing capability.
- Nano and micro mix and match integration.
- Wide range of materials and devices.






## Core competency

- Advanced semiconductor processing and materials characterization for advanced technology.
- Broad research domain: Nano-electronics, flexible electronics, spintronics, quantum technology, microfluidics, sensors and photonics.

## Our Expertise

E6NanoFab houses over 20 principal investigators and 120 researchers and academic staff with extensive years of research expertise in materials and advanced semiconductor devices.

| | | |
|---|---|---|
| Nano-electronics<br>Advanced Semiconductors<br>Photonics | Flexible and Stretchable Electronics | Magnetics (Spintronics) |
| Bioelectronic System-on-Chip | Quantum Technology | Next-generation Artificial Intelligence Hardware |

## What do we offer?

- E6NanoFab is open for access to all academic researchers and industry collaborators.
- We help you match your R&D requirements with right experts to solve specific problems.
- Industry partnership programme to collaborate on leading-edge research projects.

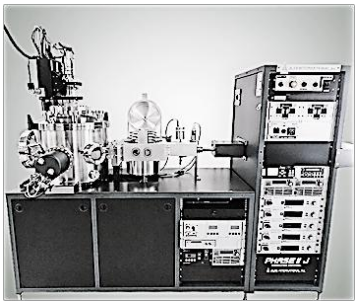
The flexibility of E6NanoFab deposition and growth equipment allows custom configuration for wide variety of application and development purposes.

## Atomic Layer Deposition (ALD)

- Precursors: Solid, liquid & gas.
- Films: $Al_20_3$, $HFO_2$, ZrO, HZO & TiN, ZnO .
- Picosun | L5 Cleanroom.

## Plasma Enhanced Chemical Vapour Deposition (PECVD)

- Up to 8 mass flow-controlled gas line.
- Targets: SiNx, $SiO_2$, & a-Si.
- Oxford | L5 Cleanroom.



## Ultra High Vacuum Metal and Dielectric Sputtering

- Up to 800°C on substrate.
- $O_2$ environment heating
- Targets: Ti, Al, IGZO, ZnO, TiN, Mo, W, Nb , Ni, Ag, Sn , ITo & etc.
- Gases: Ar, $N_2$ & $O_2$.
- Substrate RF bias cleaning
- AJA | L1 Cleanroom.

## Ultra High Vacuum E-Beam Evaporator

- Up to 800°C on substrate.
- $O_2$ environment heating.
- Targets: Ti, Al, Si, $SiO_2$, Ag, Au, Pt, Pd, TiN, Mo, Ni, $Ta_2O_5$ ,Nb, Cr, $Al_2O_3$, & ITO.
- Substrate RF bias cleaning
- AJA | L1 Cleanroom.

## Thermal Evaporator

- Irregular to 8” diameter wafer.
- Targets:  Al, Ni, Ti, Au, Au-Ge, Pd & Pt.
- Edward Auto 306 Turbo | L2 Dry Lab.

## Molecular Beam Epitaxy System (MBE)

The fully integrated MBE system allows deposition of hetero-structures and semiconductors. IV and II-VI group deposition chambers are integrated with
transfer chamber and load lock. The system has 5 ports for each chamber.

- Effusion cell for chalcogen material up to 1300°C (Si, Ge, Sn).
- Heating up to 1000°C with heating rate up to 20°C per minute.
- Available Material for Group IV: Si, C, Ge, Sn.
- Transition metal targets: Mo, W, Zr, Hf.
- Chalcogen targets: S, Se, Te.
- Base Pressure : better than 5 x 10-10 Torr
- ULVAC | L6-06-11

## Ion Beam Deposition and Etching (IBE)

- SIMS option is available to enable in-situ measurement of sputtered material from substrate.
- Etch rate: > 8 nm/min, uniformity: ≤ 8% 3σ, rreproducibility (10 runs) ≤ 3 % 3σ.
- Deposition rate (Ta) > 6 nm/min, uniformity: ≤ 3 % 3σ , reproducibility (10 runs) ≤ 2 % 3σ.
- Available target: Si, $SiO_2$, $Si_3N_4$, Ta.
- Process Gas: Ar, $N_2$, $O_2$ .
- SCIA Coat 200 | L1 Cleanroom.


## Xenon Difluoride ($XeF_2$) Etcher

- The $XeF_2$ etcher is a kind of vapour etcher where reactive gas spontaneously reacts with a material in vapour phase.
- It can etch Si and Ge isotopically and offers excellent selectivity to various materials such as Al, $SiO_2$, $Si_3N_4$ and photoresist.
- L2 Dry Lab.

Etching is a process for pattern creation and surface treatment in micro-nano device fabrication. E6NanoFab makes available dry and wet etching systems to support the diverse process requirement.

## The Integrated Inductive Couple Plasma (ICP) Etch Cluster

The 3-chamber-modules advanced dry etching cluster system for micro- and nano-machining of various materials.

- Size: 8” wafer.
- 300 mm diameter alumina discharge chamber.
- Up to 8 mass flow-controlled gas lines for each module.
- Base pressure $1\times10^{-6}$ torr or better.
- Oxford | L5 Cleanroom

### 1. The Metal Etch Module

- Coolant-cooled/electrically heated etch lower electrode, working temperature: -20 ºC to 80 ºC.
- Standard gas line and MFC for nontoxic gases ($SF_6$, Ar, $O_2$, $N_2$).
- Bypassed gas line and MFC for toxic gas ($Cl_2$, $BCl_3$, HBr, CH4).
- External gas pod gas line heating kit for low vapour pressure gases ($BCl_3$).

### 2. The Dielectric Etch Module

- Coolant-cooled/electrically heated etch lower electrode, working temperature:
- -20 ºC ± 80 ºC.
- Standard gas line and MFC for nontoxic gases ($SF_6$, Ar, $O_2$, $N_2$, $C_4F_8$, $CHF_3$).
- Bypassed gas line and MFC for toxic gas ($Cl_2$).

### 3. The III-V Compound Etch Module

- Cryo-cooled/electrically heated etch lower electrode, working temperature: -20ºC to 350 ºC.
- Rapid cooling from cryo to chiller mode, from 200°C to 20°C .
- Standard gas line and MFC for nontoxic gases ($SF_6$, Ar, $O_2$, $N_2$).
- Bypassed gas line and MFC for toxic gas ($Cl_2$, $BCl_3$, $H_2$, $H_2S$).
- External gas pod gas line heating kit for low vapour pressure gases ($BCl_3$).

## Reactive Ion Plasma Etching System

- Materials surface etching & activation
- 2D material surface treatment.
- Wafer size: up to 200mm or 8”.
- Gas Flows: Ar, $O_2$
- RF power: 13.56MHz / 20-300W adjustable.
- Manual & Automatic Operation Mode.
- Uniformity within wafer: 2% - 5%.
- Femtoscience VITA8 | L1 Cleanroom.

## Plasma Asher

- Uses oxygen to remove photoresist.
- Wafer size: up to 200mm or 8”.
- Gas Flows: Ar, $O_2$
- µ-wave Power: 2.45GHz, 1000 watt, continuously adjustable.
- Uniformity within wafer: 2% - 5%.
- Wafer to wafer: 2% - 4%.
- Samco Plasma Asher | L5 Cleanroom.

Annealing is a basic process in the semiconductor device fabrication involving heating wafers in order to activate dopants, change film to film or film to wafer substrate interfaces, densify deposited films, change states of grown films, repair damage from implants, move dopants or drive dopants from one film into another or from a film into the wafer substrate.


## Rapid Thermal Processing (RTP)

- Temperature up to 1000 °C.
- Ramp rate up to 100°C/sec.
- Heat uniformity ± 2°C for 8” wafer.
- Anneal in $N_2$ , $O_2$, Ar and Forming gas.
- Annealsys AS-One | L1 Cleanroom.

## Rapid Thermal Annealing (RTA)

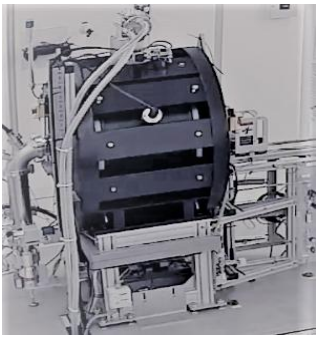
- Heat samples to 900°C in less than 24 seconds using an infrared gold image.
- Heating rates of 50°C/sec.
- Temperature uniformity of ± 2°C.
- Heating in a variety of atmospheres including air, vacuum and N2 gas.
- Vacuum environment $10e^{-6}$ torr.
- Mila 3000 | L2 Cleanroom.

## Horizontal Furnace

- Deposition: SiO2.
- Substrate Size: 8’ wafer only.
- Product yield: 40 wafer/ run max.
- Heater temp: 200 to 1000 ℃.
- Heater zone: 1 to 3 zone.
- ULTECH | L1 Cleanroom.

## Magnetic Annealing System

In magnetic annealing, an external magnetic field is applied during the annealing process which serves as an effective process to enhance the performance of magnetic devices and materials.



- Magnetic field: 0 to 8.0 Tesla.
- Wafer size: 2” (51 mm) circular Ø and 5 product wafers.
- Wafer orientation: In plane or perpendicular to magnetic field direction.
- Temperature range: 200°C - 450°C.
- Max wafer exit temp: 60°C.
- TEL MATr 8000 | L1 Cleanroom.

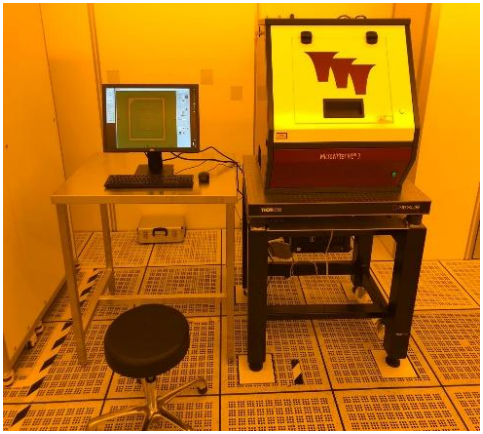
Lithography is a process where a pattern written or transferred to a substrate. At E6NanoFab, Electron-Beam Lithography, Laser-Writer, Micro-Writer, and Mask-Aligner tools serve to pattern a variety of materials from sub-10 nanometers up to 100's of microns with full 200mm writing capability.


## Laser Writer

- Maximum substrate size: 9" x 9".
- Minimum substrate size: 10 x 10 mm².
- Maximum write area: 200 x 200 mm².
- Substrate thickness: 0 to 6 mm.
- Illumination source: Diode Laser (405 nm) for standard positive resist exposure.
- Direct writing with minimum feature size of 0.6 µm.
- High accuracy overlay alignment of 400 nm.
- Vector Exposure Mode offers five different line widths.
- Heidelberg DWL 66⁺ | L1 Cleanroom.

## Micro writer

- Substrate size: Min 1cm x 1cm; Max 9"x 9"
- Maximum write area: 8"x 8"
- Substrate thickness: 0 - 10 mm
- Motion stage minimum XY step size: 4nm
- Maximum resolution: 0.6µm
- Optical surface profiler Z resolution: 100nm
- Exposure wavelength: 365nm and 405nm
- Maximum writing speed: 50 mm2/minute at 1 µm & 15 mm2/minute at 0.6 µm
- Overlay alignment accuracy at best resolution: ± 0.5µm
- Mask design software: Clewin supplied
- Model: Durham Magneto Optics (DMO) ML3 Pro
- L1 Cleanroom Class 10



## Mask Aligner

The mask aligner operates either in contact or in proximity mode and able to handle a wide range of substrate sizes from small pieces up to 200mm wafers.

## MA8

- Substrate: 25 mm up to 250 mm round; 200 x 200 mm square.
- Mask size: 2” x 2” up to 9” x 9”.
- Imprint lithography up to 150mm.
- Wavelength: 350 to 1200 nm.
- TSA alignment accuracy: <0.5µm.
- BSA alignment accuracy:<1.0 um.
- Infra-red (IR) Alignment , BSA alignment accuracy ≤ 1µm.
- UV uniformity: +/-3.5% for 8” wafer.
- Patterning of structures resolution below 0.8 µm.
- Alignment accuracy down to 0.25 µm.
- (SCIL) / PDSM Imprinting Lithography resolution better than 100nm.
- SUSS MicroTec MA8 | L1 Cleanroom.

## NanoNex Imprint Lithography System

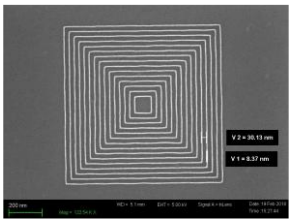
The NanoNex 2000 Imprint System delivers both thermal and UV nanoimprint lithography for advanced micro- and nanopatterning. Engineered for optimal performance on ceramic sol-gel surfaces, the system features built-in capabilities for extending master mold lifetime through intermediate polymer and ceramic sol-gel stamp replication processes. Additional technical specifications are outlined below.)


- Substrate and mold size: ≥150 mm diameter/diagonal (larger sizes preferred)
- Imprint area: ≥150 mm diameter/diagonal
- Imprint stack thickness: ~1 to 9 mm · Imprint feature size: down to ~20 nm
- Maximum imprint pressure: ~30 to 60 bar
- Maximum imprint temperature: ~100 to 250 °C
- Resolution: sub-20 nm in UV and thermal imprint modes
- Customizable Consumables Support – accommodates user-supplied masks, molds, polymers, and coating materials for specialized applications
- NanoNex 2000 | Level 2 | Cleanroom

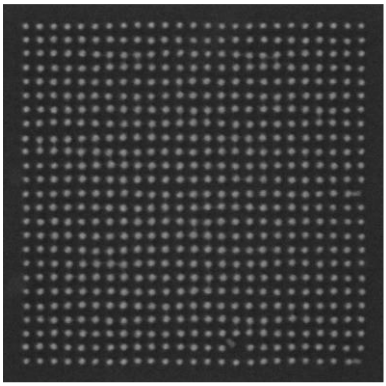
## Electron Beam Lithography - Ultra High Performance (Raith EBL 5200)

- Automated wafer and multi-sample exposures
- Automated exposure parameter switching and calibration, allowing seamless and stable switching between high throughput and high resolution
- Fast and error-free sample alignment
- Advanced fracturing modes for lowest line-edge roughness
- Raith EBPG5200 | L1 Cleanroom.


| Parameters | RAITH EBPG 5200 |
|---|---|
| Beam Energy | 50, 100 kV |
| Beam Current | 50 pA to 200 nA |
| Max Substrate/wafer size | 200 x 200 mm |
| Max Write Field | 1 mm x 1 mm |
| Max Writing Speed | 125 MHz |
| Resolution | 7nm |
| Overlay accuracy | < 20 nm |
| Stitching accuracy | < 20 nm |
| Aperture size | 200, 300, 400 µm |
| Automatic Cassette loader | 10 Cassettes (substrates 3mm-8”) |
| In-plane correction and overlay Alignment level | Full Automation and easy operation |



Nested structure with Pitch 20 nm & linewidth 5 nm



Dot structure with Pitch 20 nm & Dot 5 nm

## Solvent Wet Bench

- Stainless steel perforated workspace.
- Stainless steel solvent sinks.
- DI water and N2 Teflon gun.
- Solvent Wet bench
- Cleanrooms and wet lab at L1, L2 and L5

## Acid Wet Bench

- Quartz tank for processing 1 cassette of 8” wafers.
- Quartz tank for processing 1 cassette of 6” wafers.
- DI water and N2 Teflon gun.
- Quick Dump Rinse.
- Acid Wet bench | Cleanrooms: L1 and L5

## UV Ozone Stripper

- Maximum wafer size: 6”.
- Maximum Sample Thickness – 5mm.
- UV Light Source – Hot cathode, low-pressure mercury vapor lamp.
- Ozone generator – Silent discharge type.
- SAMCO UV-1 | L1 Cleanroom.

## Chemical Mechanical Planarization (CMP)

- Wafer size: up to 200mm or 8”.
- Chip carrier: 15mm x 15mm.
- Metal and dielectric Planarization (Cu, Al, $SiO_2$, SiN, W).
- Within wafer non-uniformity 5%.
- Run to run non-uniformity 5%.
- Finishing surface roughness 1nm.
- Logitech CMP | L1 Cleanroom.


## Wafer Dicing

- Dicing of full wafers up to 8” and piece-parts.
- Feature extremely thin diamond blade to dice or groove semiconductor wafers and other work pieces.
- Automatic work-piece loading, alignment, and unloading.
- Automatic, Semi-automatic and Manual mode.
- Accretech SS20 | L3 Metrology Lab.

## Wire Bonding

- Deep access 90º wire or ribbon feed.
- Single point tab/lead bonding.
- Bond force range: Adjustable, 10 to 250 grams.
- Transducer: ½ wave, 63 KHz (nominal).
- Ultrasonic: Built-in, 8 bit, 4 watts (Ultrasonic Positioning Utility).
- Wire range: 0.7 to 2.0 mils , 1x10 mil gold ribbon.
- Westbond 7674E | L5 Dry Lab.

## Optical Microscope

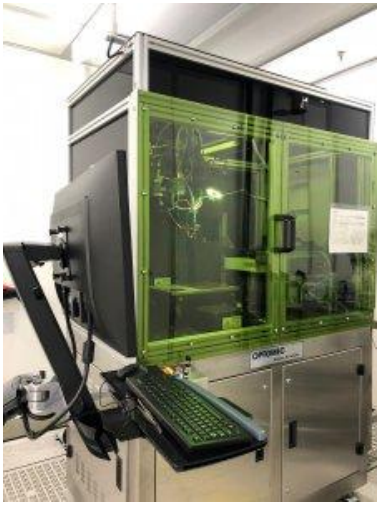
- 200mm wafer and mask inspection.
- 8 x 8 motorized stage; stroke: 205 x 205mm.
- Coarse/fine movement changeover possible.
- Software for various measurements, video recording and image processing.
- Bright/Dark Field .
- 2D and 3D stitch mapping.
- Nikon Eclipse, Keyence
- Cleanrooms and dry lab: L1, L5 and L2

## 2D Material Transfer Station w Glovebox


- Fully motorized
- Can move sample: X,Y,Z Rotation (up to 50mm / ±180° -> almost 360° total).
- Can move mask: X,Y Rotation (up to 50mm/90°)
- Can tilt mask: Pitch / Roll 5°.
- Auto Focus
- Dark field capable microscope 5, 10, 20, 50x objectives.
- Sample heating: up to 180deg with 0.1deg control accuracy, Peltier cooling.
- HQ Graphene/ Vigor | L1 Cleanroom

## 3D Aerosol Jet Printer

- Enable printing of interconnects on both 2D and 3D substrates.
- Multi-level interconnects can be created by printing a dielectric material at circuit cross over points for 2D application.
- Jet can print conformal interconnects on 3D surfaces eliminating the need for wire bonding.
- Optomec Aerosol| L1 Cleanroom



## Flip Chip Die Bonder

- Sub micron placement accuracy
- Capable for substrates up to 450x150mm.
- Bonding forces up to 500N.
- Temperature: Stage 300ºC; Bonding head 450ºC.
- Semi-automatic mode.
- Fineplacer Sigma | L5 Cleanroom

**3D Two-Photon Lithography Printer – Nanoscribe GT2**

Photonic Professional GT2 is a high resolution 3D printer designed for ultra-precise and rapid scientific microfabrication. Nanoscribe's Photonic Professional GT2 uses Two-

Photon Polymerization (2PP) to produce filigree structures of nearly any 3D shape by high-precision 3D printing: crystal lattices, porous scaffolds, naturally inspired patterns, smooth contours, sharp edges, undercuts and bridges are all manufacturable with high resolution. More than a thousand successful research projects by Nanoscribe customers and system users are evidence of the power of two-photon lithography.

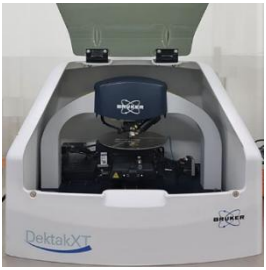
- Fully motorized
- Printing technology Layer-by-layer Two-Photon Polymerization
- Minimum XY feature size 160 nm typical; 200 nm specified*
- Finest XY resolution 400 nm typical; 500 nm specified*
- Finest vertical resolution 1,000 nm typical; 1,500 nm specified*
- Layer distance variable, 0.1 – 5.0 µm*
- Maximum object height 8 mm*
- Build volume 100 × 100 × 8 $mm^3$ *
- Minimum surface roughness Ra ≤ 20 nm*
- Max. scan speed from 100 to 625 mm/s*
- * Values may vary depending on the Solution Set, objective or photoresin in use
- E6-02-09, Class 10000

A group of imaging and measurement tools are available to provide electrical measurement, material analysis, process control parameters, etc to enable our user to achieve the most accurate result possible.

## Ellipsometer


- Sample size: Coupon size to 200mm or 8”.
- Microspot: 60 µm × 120 µm at 60°.
  365 µm × 470 µm at 75°.
- Mapping stage: X, Y, Z, rotation.
- Semilab SE-2000 | L5 Cleanroom.

## Surface Profiler




- 4Å repeatability.
- Sample Size: up to 8” wafer.
- Z Stage: Soft touch stylus null.
- Theta Stage: Motorized 360$^{o}$ stage.
- Vision64, operation and analysis software.
- Fast data collection and analysis.
- Bruker | L1 Cleanroom.

## Atomic Force Microscope (AFM)

- Repeated measurements without damaging sample surface.
- Scanning Modes: CAFM; EFM; LFM; PFM; SCM; SKPM & etc.
- Park NX20 | L1 Cleanroom.

## Scanning Probe Microscopy (SPM)

- Peak force tapping.
- Scanning Modes: MFM; AFM; EFM; KPFM; CAFM & etc.
- Bruker Dimension Icon | L5 Dry Lab.

## Raman Microscope

The Raman microscope acquires detailed chemical images and highly specific Raman data from discrete points. It analyses both large volumes and traces of material.


- Dual laser system: 532nm & 325nm.
- Able to measure both Raman and Photoluminescence.
- Map rough, uneven, and curved surfaces.
- Transmission mapping – analyse large volumes of material and produce depth-averaged 2D images of material homogeneity.
- Volume scans – 3D views of your transparent sample's internal structure and see both the chemistry and the topography.
- Renishaw inVia Raman | L3 Metrology Lab.

## Multi-purpose X-Ray Diffractometer (XRD)

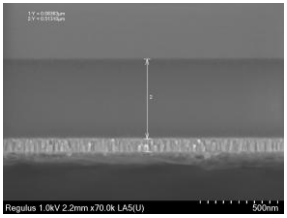
- Applications up to 4 inch: High-resolution XRD or reciprocal space mapping (RSM) (1-D and O-D with analyzer), rocking curve, XRR, grazing incidence, inplane grazing incidence, pole figure, SAXS, powder diffraction.
- Theta (θ) / 2θ up to 8 inch.
- Rigaku SmartLab | L5 Dry Lab.

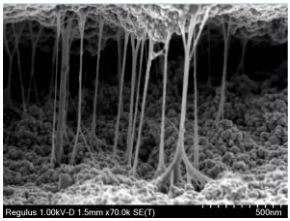
## FTIR Spectroscopy

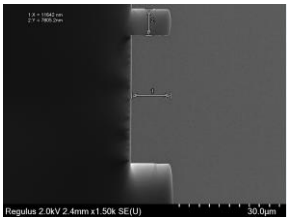
- Dual Source capable
- The Polaris™ long-life IR source
- Tungsten-Halogen white light source
- Built-in mid- and far-IR capable diamond ATR
- Nicolet iS50 | L1 Cleanroom.

## Ultra-high Resolution Scanning Electron Microscope – Regulus Series

The Regulus series employ a novel cold-field-emission (CFE) gun optimized for high-resolution imaging at low accelerating voltages. This CFE gun makes it possible to magnify high-resolution images up to 2 million times. Energy Dispersive X-Ray Analysis (EDX) is enabled for elemental analysis.




### Technical Specifications (Cleanroom Environment):

- Accelerating Voltage: 0.5 – 30kV
- Resolution: 0.8nm at 15kV (SE) 1.1nm at 1kV w/ deceleration (SE)
- Magnification Range: 20X – 2,000 X (Low Mag) 100X – 1,000,000X (High Mag)
- Detectors: Lower/ Upper/ Top, YAG BSE, STEM (Bright-Field/ PD-Dark Field).
- Stage Traverse: (5-axis Motorized) X: 0 – 110mm; Y: 0 – 11mm Z: 1.5 – 40mm ; R: 360° T: -5° – +70°
- Observable Range: 150mm Ø (MAX Sample Size)
- Specimen Exchange Chamber size: 6” Ø.
- Mountable specimen thickness: 27mm (Ø ≦ 33mm)
- Hitachi Regulus 8100 | L1 Cleanroom

### Technical Specifications (Dry Lab Environment):

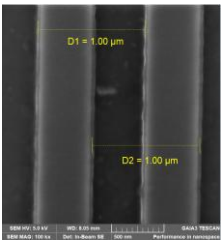
- Accelerating Voltage: 0.5 – 30kV
- Resolution: 0.7nm at 15kV (SE) 0.9nm at 1kV w/ deceleration (SE)
- Magnification Range: 20X – 2,000 X (Low Mag) 100X – 2,000,000X (High Mag)
- Detectors: Lower/ Upper/ Top, YAG BSE, STEM (Bright-Field/ PD-Dark Field), EDX
- Stage Traverse: (5-axis Motorized) X: 0 – 110mm Y: 0 – 11mm Z: 1.5 – 40mm R: 360°
- T: -5° – +70°
- Observable Range: 150mm Ø (MAX Sample Size)
- Specimen Exchange Chamber size: 6” Ø.
- Mountable specimen thickness: 27mm (Ø ≦ 33mm)
- Hitachi Regulus 8230 | L3 Metrology Lab

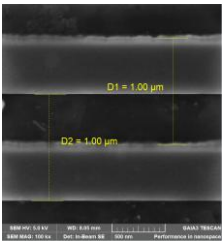
## Focused Ion Beam – Scanning Electron Microscope (FIB-SEM)

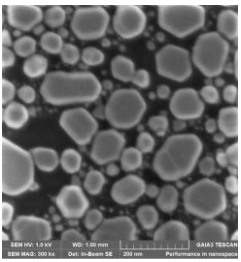
The Focused Ion Beam (FIB) instrument in select models offers in-situ nanofabrication capabilities together with SEM.

The Secondary Ion Mass Spectrometry (SIMS) techniques incorporating both material analysis and nanofabrication.


- Up to 8” wafer inspection in both SEM as well as in FIB operation enabled by the new triple lens design.
- Maximum Specimen Height: 96 mm (with rotation stage); 137 mm (without rotation stage).
- Integrated TOF-SIMS with a compact TOFSIMS detector and uses FIB column as primary ion beam with 3D compositional analysis.
- Magnification at 30kV: 4x– 1,000,000x.
- Maximum Field of View: 4.3 mm at WD; analytical 5 mm; 7.5 mm at WD 30 mm.
- Electron Beam Energy: 200 eV to 30 keV / down to 50 eV with Beam Deceleration mode.
- FIB Resolution: <2.5 nm at 30 kV (at SEM-FIB coincidence point).
- Accelerating Voltage: 0.5 kV to 30 kV.
- Ion Gun: Ga Liquid Metal Ion Source.
- Probe Current: 1 pA to 50 nA.
- FIB angle: 55°.
- Gas Injection System: Tungsten and Platinum.
- TESCAN Gaia3 | L3 Metrology Lab



## Cryogenic Probe Station – CG Series/ High And Low Temperature Vacuum Probe

The Semishare cryogenic probe station enable accurate measurement be taken at very low and/or very high temperature.

- 2” coaxial chuck.
- Ultimate Vacuum in chamber: 10^-10torr.
- Magnification: 216X if using Metallographic microscope, magnification is 20X – 1000X
- Temperature control range: 4.2K – 450K.
- RT to 8K cooling time: 1 hour 30mins.
- Start from RT to 100°C only in 30 mins.
- Mechanical Resolution 10μm/2μm/0.7μm
- Semishare SCG Series| L6-11 MBE Lab


## Four Point Probe Station

- Sheet Resistance measurement
- Automatic measurement range selection.
- Extractable data via excel spreadsheet.
- Jandel Eng Probe head with Tungsten carbine needle tips.
- Measuring range: – 10.0 μohm·cm ~ 200.0 kohm·cm.
- AIT | L1 Cleanroom.

## Vibrating Sample Magnetometer (VSM)

Dedicated for measurement of the magnetic moment of materials as a function of field, angle, temperature and time.

- Typical magnetic field at room temp: 1.5 Tesla
- Resolution at 1 Tesla: 2 µT
- Available measurement modes: hysteresis loop, IRM, angular remanence, etc.

## Scanning Magneto-Optical Kerr Microscope and Magnetometer (S-MOKE)

- Optically recording magnetization curves qualitatively on all kinds of magnetic materials.
- In-plane magnetic field: $10^{-4}$ Tesla up to 1.3 Tesla.
- Min observation area: 8mm x 8mm.
- Max observation area: 30mm x 30mm.
- Evico Magnetics | L5 Dry Lab.


## SQUID Magnetometer

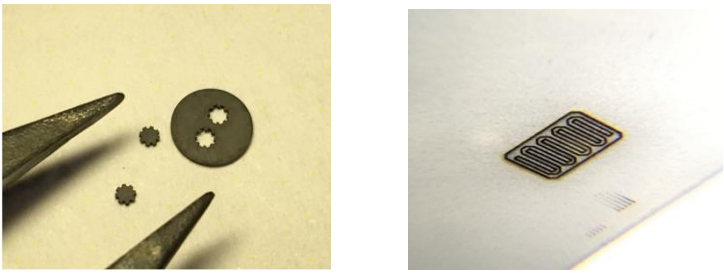
- DC and VSM data acquisition.
- Magnetic field: Up to 7 Tesla.
- Cryo genic temperature: 4k to 273k.
- Quantum Design MPMS3 | L5 Dry Lab.

Femtosecond lasers have opened up new avenues in materials processing due to their unique characteristics of ultrashort pulse widths and extremely high peak intensities. One of the most important features of femtosecond laser processing is that a femtosecond laser beam can induce strong absorption in even transparent materials due to nonlinear multiphoton absorption. Multiphoton absorption enables both surface and internal three-dimensional modification and microfabrication of transparent materials such as glasses.

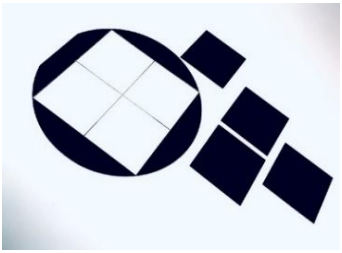
This makes it possible to directly fabricate three-dimensional microfluidic, micromechanic, microelectronic, and micro-optical components in glass. These microcomponents can be easily integrated in a single glass microchip by a simple procedure using a femtosecond laser. Thus, femtosecond laser processing has several advantages over conventional methods such as traditional semiconductor processing or soft lithography for fabricating microfluidic, optofluidic, and lab-on-a-chip devices.

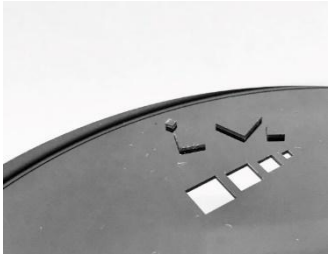
In collaboration with Centre of Quantum Technologies, we provide laser micromachining service for silicon wafer in square or circular shape of up to 525µm.

System: Oxford Lasers | L5 Dry Lab

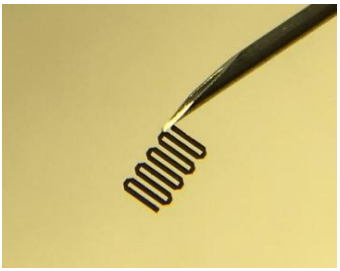


Laser micro-machining of macro features on
Silicon Nitrite and Ceramic material



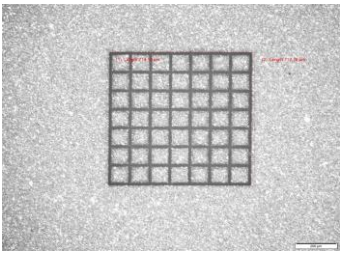


Precision Laser micromachining of Si wafer.



Laser micromachining of macro features on Stainless Steel.

Marking of Kapton like material



AU plating removal to create electrically isolation

High quality micromachining features on Alumina oxide ceramic

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